5.8 Nervous organisation, receptors and habituation

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

KEY WORDS autonomic • reflex arc • habituation • nociceptor

Objective

Practise statements 8.8-8.10: the organisation of the nervous system, receptors as transducers (rods, cones and the rest), the spinal reflex arc, and habituation.

1 Key knowledge and worked examples

■ The wiring diagram

CNS = brain + spinal cord. PNS splits into the **somatic** system (voluntary, to skeletal muscle) and the **autonomic** system (involuntary: sympathetic accelerates - fight or flight; parasympathetic calms - rest and digest).

■ Receptors are transducers

Each converts one stimulus energy into a generator potential and then action potentials: rods (many per bipolar cell - dim-light sensitivity, no colour), cones (three types, one-to-one wiring - colour and acuity), plus thermoreceptors, chemoreceptors (CO2/pH), baroreceptors (pressure), nociceptors (pain), proprioreceptors (position).

■ The reflex arc

stimulus, receptor, sensory neurone, relay neurone in the spinal cord's grey matter, motor neurone, effector. Three-neuron reflexes pass the CNS; two-neuron (monosynaptic) reflexes like the knee jerk skip the relay. Fast, involuntary, protective.

■ Habituation

A decreasing response to a repeated, harmless stimulus: with repeated stimulation, calcium channels open less, less transmitter is released, and the postsynaptic threshold is no longer reached. Learning to ignore, not to fail.

■ Worked example: reading a rod/cone table

Rods: 120 million per retina, all sharing few bipolar cells - summation gives sensitivity at the cost of detail. Cones: 6 million, one-to-one wiring at the fovea - detail at the cost of light. The exam table is this trade-off.

2 Practice

2.1 Name the two divisions of the autonomic nervous system. [2]

2.2 State one advantage of rods sharing bipolar cells. [1]

2.3 Put these in order: motor neurone, receptor, relay neurone, effector, sensory neurone. [2]

3 Exam-style questions

3.1 Describe the pathway of a spinal reflex from stepping on a pin to withdrawing the foot, naming each component in order and stating why the response is faster than a voluntary one. [5]

3.2 Explain why a person can read small print in bright light but not dim light, referring to cone and rod distribution and their wiring. [5]

3.3 A sea slug retracts its gill when touched, but after 20 touches the response fades. Explain this observation, and suggest what has changed at the synapse. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Sympathetic and parasympathetic.

2.2 Summation of weak signals from several rods lets the bipolar cell reach threshold in dim light.

2.3 Receptor, sensory neurone, relay neurone, motor neurone, effector.

3.1 Pin stimulates pain receptors (nociceptors) in the skin; sensory neurone carries the impulse into the spinal cord's grey matter; relay neurone passes it to a motor neurone (the interneuron also branches upward to the brain, but that path is slower); motor neurone carries it to the leg muscles, which contract and withdraw the foot - the arc is short and does not wait for the brain, so it is faster than a voluntary response.

3.2 Small print needs high acuity, which cones deliver at the fovea with one-to-one wiring to bipolar cells; cones need bright light because each works alone; in dim light only rods respond, but their many-to-one wiring blurs the location of the signal.

3.3 The repeated harmless stimulus causes habituation - a decreased response to a repeated stimulus; repeated stimulation of the presynaptic membrane leads to progressively less calcium entry; less neurotransmitter is released into the synapse; the postsynaptic membrane no longer reaches threshold, so no action potential reaches the gill muscle.